Factors Influencing Spatial Thinking Capabilities in a Geoscience Classroom

KUNDU Sandeep Narayan*, Grahame OLIVER and CAO Kai
Department of Geography, National University of Singapore

*Corresponding Author’s E-mail: geosnk@nus.edu.sg

Keywords: Spatial Thinking; Geospatial; Geographical Information Systems; GIS; Geoscience

Extended Abstract

The ability to visualise spatial relations—such as object shapes, relative locations and how these change over time—is a fundamental skill necessary to understand and reason about geoscience concepts (Ormand et al., 2014). Students aspiring to be geoscientists must master a variety of spatial representations, beginning with maps, cross-sections and block diagrams, and move on to unfamiliar specialised representations such as those showing directions of earthquake first motions, or the temperature/salinity structure of an oceanic water mass. Since most geoscience data are collected in one or two dimensions, students need to learn to combine data from 1- or 2-D information sources into a 3-D mental model of earth phenomena to gain a better understanding of the geoscience phenomena. Understanding concepts in geoscience and applying them to one’s work demands extensive spatial thinking capabilities and therefore learning geoscience and becoming a professional geoscientist requires high-level spatial thinking (Kastens & Ishikawa, 2006).

A student’s spatial thinking capability depends on various factors like age, gender, the majoring discipline and whether he or she has had prior exposure to a geospatial curriculum (Baldwin, 2002). Baldwin concluded that exposure to a Geographical Information Systems (GIS) curriculum for an extensive period of time can enhance students’ spatial thinking capabilities. Apparently, teaching geoscience to a mixed cohort consisting of science, arts and engineering students would be challenging owing to the wide variability of spatial thinking capabilities among them. This calls for effective designing of lectures and tutorials targeted at bridging the gap within the cohort with the different spatial thinking ability skill groups.

This article attempts to

- Identify factors influencing spatial thinking capabilities within a cohort through comparisons of their background against their responses to spatial thinking questions and tasks during the course
- Categorise students in a cohort based on spatial thinking ability and discuss its significance for improving teaching methods for geoscientific modules.

Background

The recently concluded semester involved teaching two geoscience modules to a cohort of mixed students from the science, arts and engineering faculties. From the instructors’ observations in the tutorials, exams and field excursions on student responses to spatial-centric aspects of the course, it was clear that there was a big difference in the understanding which reflected the varying spatial thinking capabilities within the cohort. The observations were analysed with the background information on the student, made available on the university’s Integrated Virtual Learning Environment (IVLE), to identify the factors influencing spatial thinking capabilities.

Methodology

IVLE provided information on gender, majoring discipline and past exposure to geospatial curriculums. Students’ responses to spatially challenging tasks during the course of the module were observed and recorded. The course activities included tutorials, exam answer sheets and field excursion notes from which certain conclusions were drawn on the factors that influence spatial thinking capabilities. Based on the students’ responses to spatial questions posed to them during the tutorials and exams, their spatial thinking skills were judged as poor, average or good. These scores were then integrated with the information from the IVLE and a statistical analysis was done, from which inferences were drawn with a view to compare with the findings of Baldwin and Wallace (2002) which led to our findings.
Figure 1. Influence of gender and prior geospatial modules taken on spatial thinking skills.

**Observations**

We observed that factors like gender, prior exposure to spatial curriculum and the discipline in which the student is majoring were influential in determining their spatial thinking abilities:

- Male students fare better than their female counterparts
- Students who major in a scientific discipline fare better than students from a non-scientific discipline
- Students with high prior exposure to a geospatial curriculum before taking a geoscience course fare better than those who have low or medium exposure.

**Conclusions and Implications**

The findings of this study bears a huge similarity to the findings by Baldwin and Wallace (2002) which was done in a different geography and published more than a decade ago. The consistency of the findings has far-reaching implications on the teaching of geosciences to a mixed class consisting of arts, science and engineering students. Assuming that applying a similar approach to teach geoscience to a cohort which consists of different spatial thinking capability skill groups will yield different results, it is important that such skill groups be exposed to different methods of teaching geoscience which could include spatially stimulating illustrations and exercises in the lectures, tutorials and field demonstrations.

The minor in Geoscience and Petroleum Exploration offered by the Department of Geography in NUS attracts students from a broad spectrum which includes the arts, science and engineering faculties. This presents a cohort with a broad range of spatial thinking capabilities, which poses a challenge for teaching the geospatial concepts with equal success. The methodology presented shall enable the lecturer to identify the factors which influence the spatial thinking capabilities of students, which when done in advance, allows for the effective design of the lectures, tutorials and field demonstration plans.
Such an exercise can result in students gaining a better understanding of geoscience concepts and can help to bridge the gap between those within the cohort with strong spatial thinking capabilities and those who are less skilled.

Acknowledgement

The authors thank the Department of Geography for providing the opportunity to teach the geoscience modules to a mix of students from various disciplines, without which the idea of the study could not be conceived.

References


